Aeronautics Committee Report to the NASA Advisory Council

Ms. Marion Blakey (Chair)

February 11, 2011

Areas of Interest Explored at Current Meeting

Topics covered at the Aeronautics Committee meeting held on January 20-21 at NASA Headquarters:

Aeronautics Budget Overview

ARMD Systems Analysis and Strategic Planning

NASA ARMD's Environmental Research Related to Aviation Emissions*

FAA Role/Policy in GHG mitigation

EPA GHG Mandatory Reporting Rule

Agency Workforce Hiring and Recruitment

Proposed Aeronautics Committee UAS Subcommittee

Aeronautics Committee 2011 Work Plan

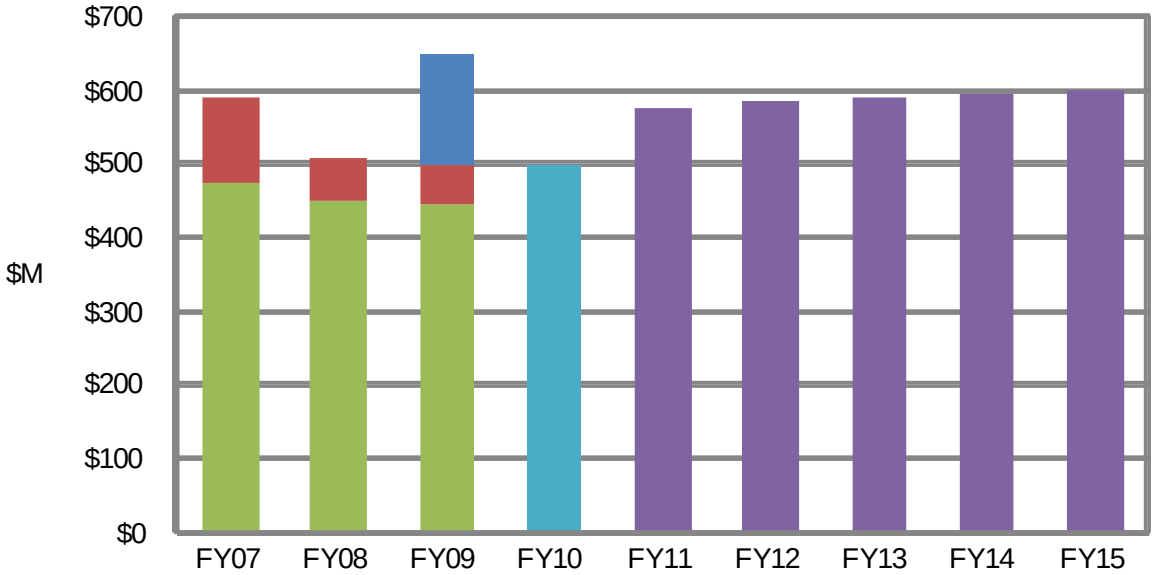
* This topic has a related observation provided by the Aeronautics Committee

Committee Information

- Members:
  - Ms. Marion Blakey (Chair)*
  - Dr. Ilan Kroo*
  - Dr. Mark Lewis*
  - Mr. Preston Henne*
  - Dr. R. John Hansman*
  - Mr. Mark Anderson*
  - Dr. Harry McDonald*
  - Mr. Paul Adams**
  - Dr. Ray Colladay (ex-officio)
- Plans for next meeting: Face-to-face Committee Meeting at Dryden Flight Research Center April 14-15, 2011.

*In attendance at meeting ** Participated remotely

NASA Aeronautics Budget for FY2007-FY2015

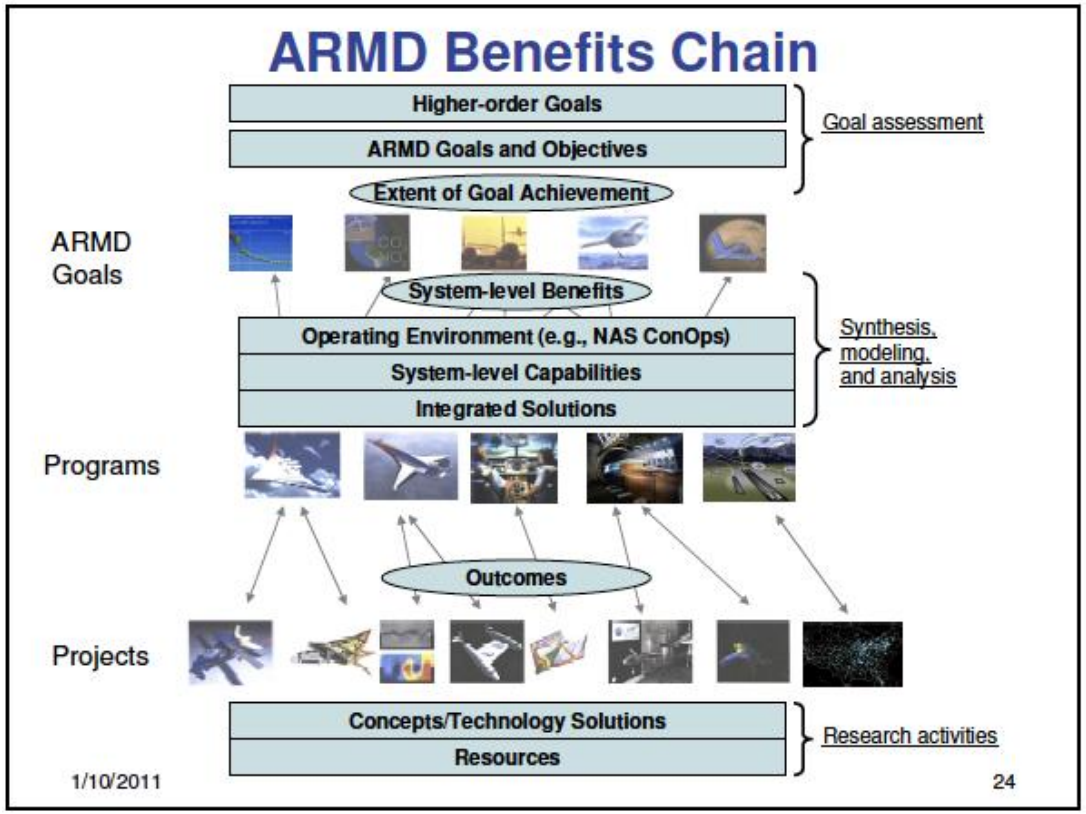


	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15
Recovery Act			$150.0						
Congressional Augmentation	$116.0	$60.0	$53.5						
Budget Requests	$477.8	$451.4	$446.5						
FY10 Enacted Budget				$501.0					
FY11 President's Budget Submit					$579.6	$584.7	$590.4	$595.1	$600.3

Note: The budget request columns for FY07 and FY08 have been adjusted from the initial request to reflect full cost simplification. The FY09 budget request column is from the FY09 President's Budget. The FY10 budget column is the enacted budget for this year.

Strategy, Architecture and Analysis (SAA)

- SAA is a new NASA ARMD organization
  - Support strategic decision making for NASA's Aeronautics Research Mission Directorate
  - Foster innovative thinking about the future of aviation
  - Enable appropriate cross-program integration
  - Establish robust dialogue on needs and opportunities with stakeholders



NASA Aeronautics

Energy and Environmental Challenges

With the expected increase in global air travel over the next 20-30 years, the reliability and environmental impact of aviation are becoming critical issues for the future of flight.

1. Fuel Efficiency
2. Emissions
3. Noise

NASA Aeronautics

Environmental Challenge: Reduce Harmful Emissions

What are we trying to do?

- Develop enabling concepts and technologies to dramatically reduce or eliminate harmful emissions affecting local air quality/health and global climate change attributable to aircraft energy consumption.

How is it done today, and what are the limits of current practice?

- Aircraft use conventional jet fuels from petroleum sources which increases carbon dioxide (CO_2) and other emissions into the environment
- Current large engines produce LTO nitrogen oxide (NOx) emissions that are approximately 50% less than 2004 CAEP* steering group levels but are still greater than NASA's emissions goals

What is new in our approach?

- **NASA approach is two-fold: fundamental research within the Fundamental Aeronautics Program (FAP) and integrated systems-level research in the Integrated Systems Research Program (ISRP)**
  - New technologies to help reduce emissions from aircraft engines
  - Alternative fuels research to enable use of fuels with less impact on the environment
  - Validated Computational Fluid Dynamics (CFD) tools to analyze, design, and predict the performance of new low-emissions combustor designs

What are the payoffs if successful?

- Reductions in both ground level and altitude emissions from aircraft
- Reduced impacts of aviation on climate change by reducing emissions that contribute to global warming

* Committee on Aviation Environmental Protection (CAEP)

Fundamental Aeronautics Program

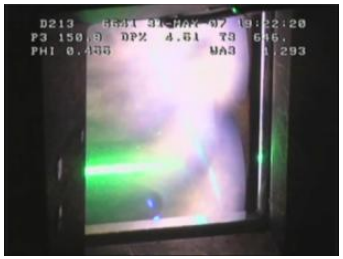
Environmental Challenge: Reduce Harmful Emissions

Low Emissions Concepts

- Combustion dynamics studies of lean burn ultra low emissions concepts
- Novel low emissions concept development
- Enabling Control Components
- Active Combustion Control
- CMC Combustor Liners
- Development and testing of low emissions concepts
- Constant Volume Combustion

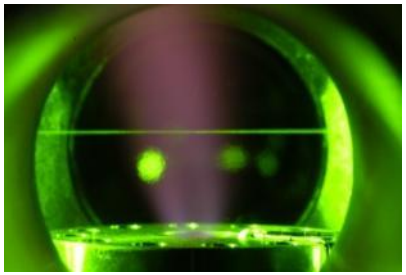
Benefits of Successful Completion

- Significantly Reduced Impact of Aviation on the Environment
- Increase in Alternative Fuel Use for Aviation



Validation Experiments

- Single element LDI validation experiment for advanced modeling tool development
- Advanced low emissions concepts
- Well-stirred flow reactor for chemical kinetics studies

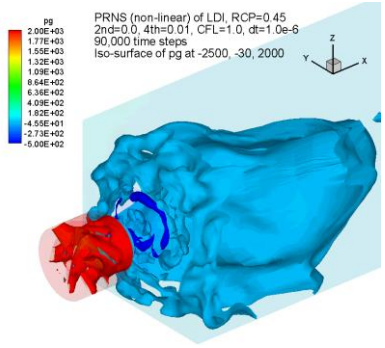


Alternative Fuels

- Alternative Fuel combustion testing in flametubes and engines
- Fischer-Tropsch reactor studies and catalyst development
- Biofuels fundamental studies and modeling

Combustion CFD Modeling

- Chemical Kinetics for conventional and alternative fuels
- Primary/Secondary Atomization models
- Turbulent combustion modeling
- RANS/URANS/PRNS/LES Models
- Radiation Heat Transfer
- Combustion Dynamics
- Soot Modeling
- Spray Vaporization



Altitude Emissions and Exhaust Plume Studies

- Flight testing with emissions testing for conventional and alternative fuels
- Particle Altitude Simulation chamber for particulate and contrail studies

SFW Funded Partner Funded Future Work

Fundamental Aeronautics Program
Aviation Alternative Fuel eXperiment (AAFEX)

- AAFEX was conducted at NASA's Palmdale, CA aircraft facility in January-February, 2009 to investigate the effects of synthetic fuels on:
  - engine performance
  - engine and auxiliary power unit gas and particle emissions and characteristics
  - volatile aerosol formation in aging exhaust plumes
- Considered the first ever test of 100% synthetic fuel. And although some seal issues were encountered significant reduction in particulates and aerosol emissions were obtained.
- Next steps:
  - FY11 AAFEX-2 Experiment using NASA DC-8 with biojet fuels

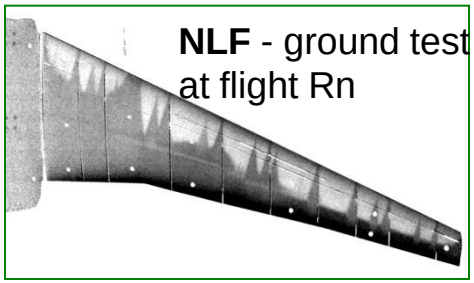
Integrated Systems Research Program

Environmental Challenge: Addressing Fuel Burn (CO_2 Emissions)

DRAG REDUCTION via Laminar Flow

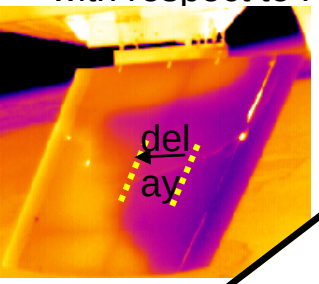
Addressing concepts & barriers
to achieving practical laminar flow on transport a/c

HLFC - revisit crossflow expt
- understand system weight



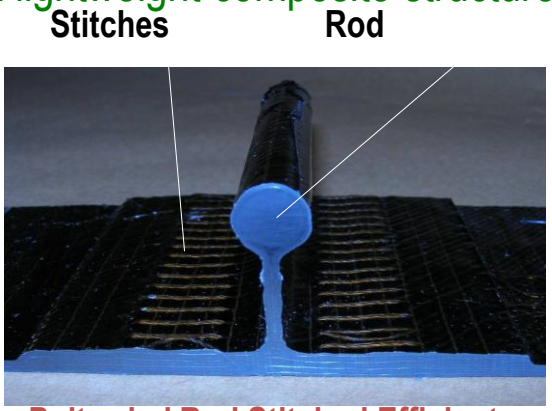
NLF - ground test
at flight Rn

DRE - exploring the limits
with respect to Rn

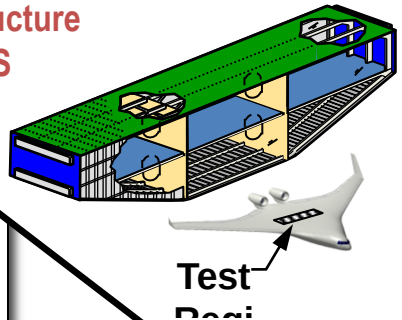


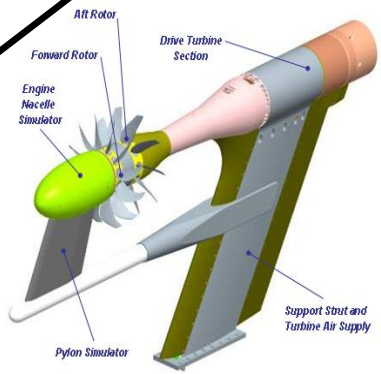
WEIGHT REDUCTION via Advanced Structures

Moving from "safe-life" to "fail-safe" design
with a lightweight composite structure

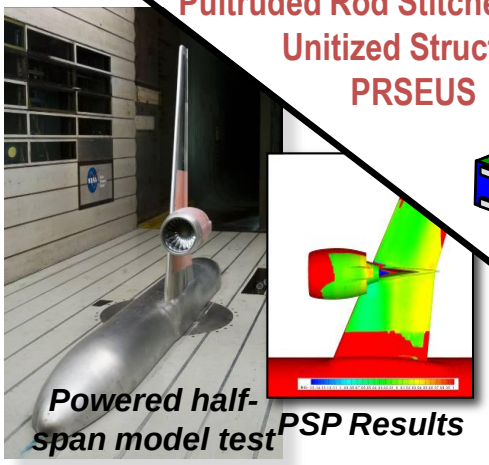


Pultruded Rod Stitched Efficient
Unitized Structure
PRSEUS





Open Rotor Propulsion Rig



Powered half-span model test

PSP Results

SFC REDUCTION via UHB

Addressing multidisciplinary challenges from subcomponent to installation
to achieve ultra-high by-pass ratio

International and Domestic Regulation of Aviation Environmental Issues

- International Civil Aviation Organization (ICAO)
  - ICAO sets standard and Recommended Practices on Noise and Emissions accepted globally
  - Agreed in September 2010 to voluntary efficiency goal (2%) and mandatory fuel reporting. States developing plans of actions.
- Bilateral Air Service Agreements
  - Environmental Provisions
- United Nation Framework Convention on Climate Change (UNFCCC)
  - General commitment to reduce certain greenhouse gas emissions
  - Ongoing discussions on regulating inernational bunker fuels. Proposals for international tax.
- Kyoto Protocol
  - Specific targets for reductions
- U.S. Congress considered a number of climate and energy bills that could price or cap carbon emissions. Prospects for legislation unclear.
- E.U. continues to seek to include aviation in their emissions trading system.

Key FAA Environment & Energy R&D Initiatives

- Improved science and modeling:
  - Aviation Climate Change Research Initiative (ACCRI);
  - Aviation Environmental Design Tool (AEDT);
  - Aviation Environmental Portfolio Management Tool (APMT);
  - Environmental Design Space (EDS)
- Operational Procedures:
  - Optimized Profile Descents (OPD);
  - Atlantic Interoperability Initiative to Reduce Emissions (AIRE);
  - Asia & South Pacific Initiative to Reduce Emissions (ASPIRE)
- Engine and airframe technologies:
  - Continuous Lower Energy, Emissions, and Noise (CLEEN) technologies program
- Alternative Fuels:
  - Commercial Aviation Alternative Fuel Initiative (CAAFI)
- Policy initiatives:
  - NextGen Environmental Management Systems (EMS)

NASA Aeronautics

Important Partnerships in Emissions Research

FAA CLEEN Program

- ERA and SFW are collaborating with the FAA to ensure that work is well coordinated.
- NASA provided technical support to solicitation development and proposal review.

Versatile Affordable Advanced Turbine Engine (VAATE) Program

- Focus of related VAATE efforts are primarily in efficiency improvement, but these will have an impact on emissions
- NASA coordination through ISRP and FA Programs as well as with GRC

Commercial Aviation Alternative Fuels Initiative (CAAFI)

- NASA participates in CAAFI meetings to help ensure that alternative fuel research is coordinated with the broader community.

Aviation Climate Change Research Initiative (ACCRI)

- Ongoing NASA coordination helps ensure that we are aware of changes in more global modeling and impact analysis as well as ensuring that the latest technology projections from NASA are available.

Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER)

- Coordination from vehicle and Air Traffic Management perspective
- Many PARTNER efforts are well coordinated with NASA Research Announcment activities

Overview: U.S. EPA GHG Reporting Program

Goal of GHGRP is to collect accurate and timely data on GHG emissions to inform future policy decisions.

- Generally requires facilities across certain sectors of the economy emitting ≥ 25,000 mtCO2e annually to report to EPA GHG emissions and other related data.
- Measurement began in 2010 for most categories with first reports due by March 31, 2011.
- EPA estimates that over **13,000 facilities** will be reporting, accounting for 85-90% of U.S. GHG emissions.
- Reporting only, no control requirement.
  - Control measures already in place often required to be reported

Support of EPA in CO_2 Standard Development

- EPA is involved in development of future aircraft CO_2 standards and certification requirements through the International Civil Aviation Organization's Committee on Aviation Environmental Protection (CAEP) CO_2 Standard Task Group
- NASA ARMD has been supporting the EPA Office of Transportation and Air Quality (OTAQ) in CO_2 Task Group activities over the past several months
- EPA OTAQ is keenly interested in continued assistance from NASA, particularly additional CO_2 benefits assessment of past, present, and near-term technologies and their technology readiness, cost, and implementation timeframes under various scenarios

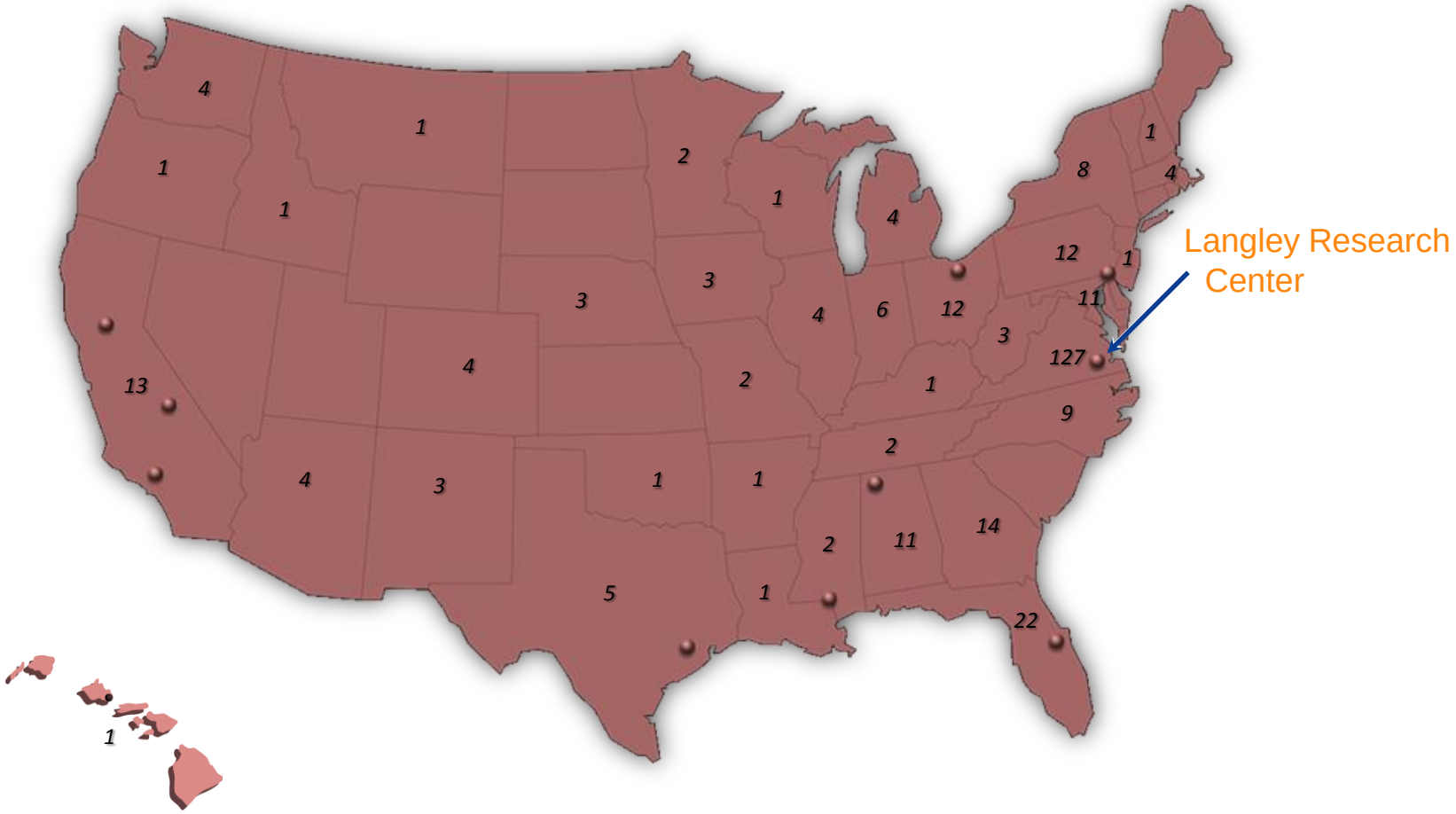
Committee Observations

1) The Committee is encouraged to see strong coordination and collaboration in research between NASA and FAA concerning environmental impacts of aviation and hopes that collaboration will continue. The Committee also believes NASA's technical expertise and research can lend support to EPA's standards setting and regulatory policy initiatives as related to aviation, such as greenhouse gas emissions, and therefore supports a more proactive collaboration with EPA.

NASA's Workforce Recruitment

- OHCM conducted an analysis of hiring data in order to identify trends in hiring at NASA between FY2006 and FY2010.
  - Provided updates to a presentation made to the NAC Human Capital Committee in July, 2009 and the full NAC in April, 2010
  - Hire data included all outside hires and CO-OP conversions from FY 2006 through FY 2010
- Data from the analysis addressed:
  - What proportion of hires at the Agency are freshouts.
  - Of the freshouts, what proportion are cooperative student conversions versus outside hires.
  - Geographical diversity of NASA hires.
- While hiring at centers seems to be geographically local, efforts have been made to recruit and hire from outside those local geographic boundaries
  - Broaden scope and number of universities targeted for recruitment
  - Leverage Administration and Agency efforts to reach out to the STEM community and pipeline
- OHCM also noted that several factors influence NASA's hiring and recruitment
  - Programmatic constraints
  - Budget constraints
  - Low attrition rate (leads to minimal hiring opportunities)

Sample Hiring Data LaRC 2006-2010



Proposed UAS Subcommittee

- The Aeronautics Committee, at the request of the ARMD Associate Administrator, is considering establishing a UAS Subcommittee to provide advice and recommendations on a wide range of UAS issues
- The Subcommittee will review and assess NASA's approach, progress, and plans for developing strategies and capabilities that reduce technical barriers related to the safety and operational challenges associated with enabling routine UAS access to the NAS.
- Draft objectives may include:
  - Provide advice and recommendations on the overall objectives, approach, content and structure of the UAS Integration in the NAS Project
  - Review and evaluate NASA's approach for addressing technical issues such as human factors and air traffic management
  - Provide advice and recommendations on strategic cooperation with other stakeholders performing UAS related development work (e.g., FAA and DoD)

CY 2011 Work Plan

Review and/or advise on:

1) NASA Aeronautics' goals and progress for mitigating the environmental impact of aviation, with particular focus on the collaboration and coordination with other federal agencies. Specifically, the Committee will advise on NASA research related to aircraft emissions and recommend improvements to complement current and planned greenhouse gas (GHG) emissions and climate change-related regulatory policy.

2) Initial implementation of the key FY11 research initiative Unmanned Aircraft Systems Integration in the NAS.

3) Initial implementation of the key FY11 research initiative Verification and Validation of Flight Critical Systems.

CY 2011 Work Plan (cont.)

4) Development of ARMD wide methodology utilizing systems analysis and strategic planning to support portfolio investment decision-making process.

5) Current process for the transfer of NextGen technologies to the implementation and user community, and advise on ways to improve the timeliness and effectiveness.

6) Strategy in developing international collaborations and advise on ways to enhance and leverage stronger collaborations where warranted.